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Contact: Jodi Dunlop
Public Relations
678-539-1140
jdunlop@ashrae.org
1791 Tullie Circle NE
Atlanta, GA 30329

ASHRAE: Implement Preventative Plans to Control Mold

ATLANTA - Due to the proliferation of mold in buildings, sound moisture management should take precedence over energy cost savings, according to a new position document from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

Energy conservation goals may conflict with moisture management goals. In fact, traditional methods of dehumidification, such as reheat systems, may increase energy use, Ron Vallort, ASHRAE president, said.

"Considering energy conservation and moisture management goals in the design, construction, operation and maintenance of HVAC systems can minimize energy use and cost," he said. "However, the impact of mold proliferation suggests that energy cost savings should not be achieved at the expense of sound moisture management."

Minimizing Indoor Mold Through Management of Moisture in Building Systems outlines ASHRAE's position on the management of moisture in buildings by describing issues related to the topic and highlighting resources available through the Society regarding the management of moisture and mold in buildings.

The document recommends that for proper moisture management include:

* Building envelopes, penetrations and building systems be designed and built to protect the indoor environment and the building materials from water infiltration or accumulation.
* Building and system design consider internal or exterior moisture that could cause condensation on surfaces or within materials.
* Building and system design, operation and maintenance provide for drying of surfaces and materials prone to moisture accumulation under normal operating conditions.
* Building and system design, operation and maintenance provide for water management of surfaces and materials that are expected to have moisture present.
* Mechanical system design should properly address ventilation air.
* Building and system design, construction and operation take into account occupant uses.
* Each building have an operation and maintenance plan.
* The sequence of operation for the HVAC system contain appropriate provisions to manage humidity, control pressurization and monitor critical conditions.
* Moisture accumulation be investigated in a timely manner and steps be taken to identify and control the course of water.

The position document, Minimizing Indoor Mold Through Management of Moisture in Building Systems, can be downloaded for free via the "position documents" shortcut on ASHRAE.org.

ASHRAE, founded in 1894, is an international organization of 55,000 persons. Its sole objective is to advance through research, standards writing, publishing and continuing education the arts and sciences of

heating, ventilation, air conditioning and refrigeration to serve the evolving needs of the public.

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POSITION PAPER:

Indoor Air Quality: Position Document

(Approved by ASHRAE Board of Directors February 10, 2005)

Executive Summary

ASHRAE published a Position Statement and Paper on Indoor Air Quality (IAQ) in February 1989. In it ASHRAE asserts the importance of IAQ and related energy conservation and public health issues. In 2000, the ASHRAE Board of Directors reaffirmed that ASHRAE standards should and do consider health impacts when setting the criteria for acceptable indoor air environment. Moreover, since 1989, much knowledge has accrued that allows statements of far greater certainty about health effects, exposures of concern, and the broad approach that must be adopted toward IAQ. Consistent with that reaffirmation, this Position Document replaces the 1989 Statement and Paper.

People in buildings frequently report discomfort, building related illness, and other symptoms that occupants believe are caused by the indoor environment (e.g., sick building syndrome [SBS]). Temperature, humidity, drafts and a wide range of indoor air pollutants: organic and inorganic gases, infectious microorganisms, other biological agents, and non-biological particles and fibers, are among indoor environmental factors implicated in occupant discomfort or illness reports. Sources of indoor air pollutants include building materials; materials used inside buildings (e.g., furnishings, cleaning products, paper); combustion appliances; office, HVAC and other equipment; tobacco smoking; people and their personal care products; the soil, vegetation and the outdoor air. Some building components may become pollutant sources through moisture incursion, accumulation of deposited particles or gases, or normal usage and maintenance.

IAQ is a multidisciplinary endeavor; therefore, good communication and cooperation must be established among professionals who share responsibility for building environments. These professionals include architects, designers, builders, engineers, maintenance and custodial staff, facility managers, and, where appropriate, medical and environmental health professionals. Good communication and cooperation must be also established with building occupants, the subject of all IAQ efforts.

Further, ASHRAE recommends:

1. ASHRAE Standards 62.1 and 55 as the two major United States (U.S.) national guidelines on indoor thermal and IAQ management.
2. Expanded public and private support for research on IAQ and its effects on people because ASHRAE recognizes that there remains a significant need for continuing research on the causes, health effects, economic importance and solutions of IAQ problems.
3. Continued government support for IAQ-related education and implementation programs because ASHRAE recognizes that widespread implementation of available IAQ knowledge, technologies and practices can significantly improve indoor environments, comfort and public health.

4. ontinued research on building energy efficiency and IAQ, which are interrelated but not incompatible.

ASHRAE will:

1. Continue to influence building design, operation and maintenance, which affect IAQ.
2. Continue to improve ASHRAE Standards 62.1and 55 and promote their broad acceptance and implementation.
3. Support relevant research on ASHRAE Standards 62.1 and 55.
4. Continue educational IAQ programs for its members and all who are involved in the multiple aspects of IAQ.
5. Continue to support communication and information exchange among all disciplines that contribute to the study and improvement of IAQ.

INDOOR AIR QUALITY

ASHRAE published a position paper on IAQ in 1989, making it the first of several major professional societies in the U.S. to develop a formal position. Since 1989, much knowledge has accrued that allows statements of far greater certainty about health effects, exposures of concern, and the broad approach that must be adopted toward IAQ.

1.0 CURRENT STATE OF KNOWLEDGE

1.1 Health and Comfort

People in buildings frequently report discomfort and building-related health symptoms, and sometimes develop building-related illnesses (Brightman et al 1997; Committee on Health Effects of Indoor Allergens 1993; Committee on Asthma and Indoor Air 2000; EPA 1992; Federspiel 1998; Mendell 1993; Menzies and Bourbeau 1997). In the last 15 years, high quality research has been conducted on the nature, extent and causes of these comfort and health effects. Discomfort complaints are commonly related to the temperature, draft, humidity and odors (Bluyssen et al. 1996; Federspiel 1998). One of the most common health complaints is of building-related symptoms including eye, nose and throat irritation; headaches, fatigue and lethargy; upper respiratory symptoms; and skin irritation and rashes (Bluyssen et al. 1996; Brightman et al. 1997; World Health Organization 1983). The term “sick building syndrome” has been used to describe the excess prevalence of this collection of symptoms. The term “building-related illness” refers to a different set of diseases including hypersensitivity pneumonitis and Legionnaires’ disease. Other health effects associated with the indoor environment include symptoms of allergies and asthma (Committee on Health Effects of Indoor Allergens 1993; Committee on Asthma and Indoor Air 2000), respiratory illnesses (Fisk and Rosenfeld 1997; Menzies and Bourbeau 1997), and toxic and systemic effects with known causes, e.g. carbon monoxide poisoning (Committee on Indoor Pollutants 1981).

Scientific studies have determined that these health effects and discomfort are associated with characteristics of buildings, HVAC systems and the indoor environment (Mendell 1993; Menzies and Bourbeau 1997; Seppanen et al. 1999). Personal and job characteristics also play a role in some aspects of these effects (Mendell 1993; Menzies and Bourbeau 1997). The indoor environment factors that have been postulated as causes of these effects are described in the following paragraphs.

1.1.1 Volatile organic compounds. Research on the health effects of volatile organic compounds (VOCs) suggests that irritation can be caused by the complex mixtures sometimes encountered indoors (Apte and Daisey 1999; Ten Brinke et al. 1998). An emerging concern is the production of highly irritating aldehydes through chemical reactions between less irritating but

commonly occurring VOCs and oxidizers such as ozone (Weschler and Shields 1997; Wolkoff et al. 1998). Indoor sources of VOCs include building materials, furnishings, cleaning products, office and HVAC equipment, tobacco smoking, people and their personal care products, and outdoor air. The most effective method to control indoor VOCs is by elimination, substitution or containment of sources.

1.1.2 Thermal environment. Studies in buildings and in climate chambers demonstrate associations of the thermal environment with thermal comfort complaints, health symptoms and perceived air quality (ASHRAE 2004; Fang et al. 1998; Fanger 1970; ISO 1994; Mendell 1993; Schiller et al 1988). Many studies have found an association of increased indoor air temperatures with SBS symptoms and with perceptions of worsened IAQ (Mendell 1993; Fang et al. 1998). Low humidities, e.g., below approximately 25% RH, are sometimes associated with mucous membrane symptoms (Mendell 1993; Reinikainen et al. 1999; Wyon 1992). Increased humidity and building dampness have been associated with upper respiratory tract symptoms, cough, wheeze, and asthma symptoms in those with preexisting asthma (IOM 2004), as well as worsened perceived air quality (Fang et al. 1998). These problems are diminished by effective control of thermal conditions and humidity (guided by ASHRAE Standards 55 and 62.1).

1.1.3 Airborne infectious agents. Human-generated infectious agents include viruses and bacteria. Higher occupant density and building-ventilation characteristics have been associated with increased incidences of respiratory illnesses caused by these agents (Fisk and Rosenfeld 1997; Seppanen et al. 1999). Engineering control strategies such as filtration, ventilation air exchange, disinfection procedures and pressure control may help to control the incidence of these illnesses.

Building occupants can also become colonized or infected by fungus and bacteria that may grow within the building and HVAC system. The associated diseases include invasive aspergillosis, legionellosis and histoplasmosis (ACGIH Bioaerosols Committee 1999; Menzies and Bourbeau 1997). Improved HVAC operation and maintenance, building envelope design, space pressure control and filtration are keys to reducing these infections.

1.1.4 Non-infectious biological agents. Important non-infectious biological agents indoors include viable and non-viable fungus and bacteria, animal dander, and the allergens from dust mites, cockroaches and plants (Committee on Health Effects of Indoor Allergens 1993; Committee on Asthma and Indoor Air 2000). The health impacts of these agents include allergies, asthma, skin rash and hypersensitivity pneumonitis (Committee on Health Effects of Indoor Allergens 1993; Committee on Asthma and Indoor Air 2000; Menzies and Bourbeau 1997). Prevention and remediation of moisture problems, good housekeeping, and adequate HVAC operation and maintenance practices can reduce indoor concentrations of these agents.

1.1.5 Non-biological particles. Important sources of indoor non-biological fine particles (e.g. those smaller than approximately 2.5 micrometers) include outdoor air, tobacco smoking and unvented combustion appliances (EPA 1992; EPA 1996a; EPA 1996b; EPA 1996c; Ozkaynak et al. 1996). Increases in respiratory symptoms, hospital admissions and cardio-respiratory death rates have been linked to higher concentrations of these particles in outdoor air (EPA 1996c). Larger non-biological particles and fibers are often produced from abrasion of building materials, furnishings and paper products (Owen et al. 1992). Exposure to these larger particles may be associated with skin and mucous-membrane irritation (Committee on Indoor Pollutants 1981). Deposited particles can be re-suspended by activities and air movement (Thatcher and Layton 1995). Ventilation rates, filtration, housekeeping, and isolation of construction and renovation areas from the occupied areas can strongly influence indoor exposures to particles.

1.1.6 Inorganic gases. Important indoor inorganic gaseous pollutants include carbon monoxide (a cause of health outcomes ranging from acute toxic effects to death [Apte 1997; EPA 2000]), nitrogen oxides and ozone (respiratory irritants [Committee on Indoor Pollutants 1981]), and

radon (a cause of lung cancer [BIER VI 1998]). Sources of combustion contaminants, e.g. carbon monoxide and nitrogen oxides, are outdoor air, tobacco smoking and combustion appliances (Committee on Indoor Pollutants 1981). The primary source of radon is usually soil gas drawn into buildings via pressure-driven flow (Nero 1988). Ozone sources are outdoor air, some air cleaners and some office equipment. Eliminating the pollutant sources, isolating the occupied spaces from these sources and space pressure control are preferred methods of controlling exposures.

1.1.7 Individual susceptibility. The above factors do not affect all people equally: susceptibility varies with a range of factors such as atopy (predisposition to allergic sensitization), prior exposure, stress and gender (ALA 1997; Mendell 1993). In some cases, the basis of the relationship is not clear. For example, the relationship between stress and SBS symptoms might arise because: (1) individuals who are more prone to reporting problems report both more symptoms and more stress, (2) individuals who suffer stress might experience more symptoms at any given level of exposure, perhaps because stress modifies biological responses, (3) organizational characteristics associated with poor maintenance of building systems may adversely affect work stress or (4) long-term experience of symptoms may lead to stress.

2.0 BUILDINGS AS COMPLEX SYSTEMS

As recognized in ASHRAE Standards 62.1 and 55 (ASHRAE 2004; ASHRAE 2004), IAQ depends on a complex set of dynamic, interrelated components, including: ventilating and conditioning systems; properly selected, positioned and installed vapor retarders in building envelopes; pollutant sources; other building components and systems that provide routes of pollutant exposure and migration; and building occupants. In recognition of these multiple factors, strategies involving combinations of preventive control and remedial practices are necessary. Typically these strategies include preventive or source control measures, effective ventilation and air cleaning, and programs to address occupant complaints (ALA 1997; EPA 1991b). Sentinel health events, such as Legionella pneumonia and hypersensitivity pneumonitis, require a procedure to identify and remediate the source of the problem.

Parallel to understanding the direct impact of the indoor environment on building occupants, it is important to establish good communication among all parties who are responsible for building environments (ALA 1997; ASHRAE 1996). This would include designers, builders, engineers, maintenance personnel, facility managers and the building occupants. Communication about IAQ should occur at all stages in the life of a building, from design to destruction. The ASHRAE Commissioning Guideline (ASHRAE 1996) details the process for documentation, which forms the basis for the required communication.

There is also much to be gained from greater liaison between professionals in the building, medical and environmental health fields. For example, medical professionals are encouraged to treat asthma in children with both medication and environmental modifications at home and school.

2.1 Pollutant Source Control

Pollutant source control measures are often the most effective and energy efficient means of preventing IAQ problems (ALA 1997; Godish 1989). Although there is insufficient standardization of ways to assess indoor pollutant emission rates, market pressures are driving the collection of relevant information. As a result, the selection of low-emitting products with less harmful emissions has become more common. The recognition that pollutant emissions are not constant during the life of a product has led to different ventilation strategies early in the life of a building. These include higher outdoor air fractions and extended hours of HVAC operation. However, some building components may become pollutant sources as they age, through moisture

incursion, accumulation of deposited particles or gases, decay or normal wear and tear. Fires and floods are extreme events that can create strong pollutant sources that require remediation.

2.2 HVAC Systems

HVAC is critical to maintaining acceptable indoor environments in many climates and building types. The intent of HVAC is to provide for occupant comfort and health. Failure to properly design, install, commission, operate and maintain HVAC systems is one of the possible explanations for the observed association of air conditioning with increased SBS symptoms (Mendell and Smith 1990; Mendell 1993). Symptom prevalences vary widely among buildings with any type of HVAC (Fisk et al. 1989; Zweers et al. 1992), suggesting that the means of applying HVAC, plus other factors, are determinants of symptoms.

While ventilation is not the only determinant of IAQ, perceived air quality and health outcomes generally improve as ventilation rates increase (Seppanen et al. 1999). In current practice, minimum ventilation rates are recommended by ASHRAE Standard 62.1. Interpreting more recent research, there are health, productivity and perception benefits from increasing ventilation rates above the current ASHRAE values (Apte et al. 2000; Milton et al. 2000; Sundell et al. 1994; Wargocki et al. 2000). Qualitatively, the relationships of ventilation rates with health outcomes, obtained from studies in offices, should apply for other types of buildings; however, the specific ventilation requirements may vary. More generally, the optimum ventilation rates for a particular building will depend on indoor pollutant emissions, outdoor pollutant levels, the requirements of the building occupants and energy considerations.

HVAC systems also affect space pressure differences that control the inter-zonal transport of pollutants, and this may prevent or promote water vapor condensation in walls. Filtration and gaseous air cleaning within HVAC systems can strongly influence indoor pollutant concentrations (Committee on the Assessment of Asthma and Indoor Air 2000; Fisk et al. 2000; Weschler et al. 1994). Additionally, HVAC systems control the indoor thermal conditions, which impact both thermal comfort and SBS symptoms.

2.3 Commissioning and Premature Occupancy

Premature occupancy, before commissioning or even before all construction has been completed, is now recognized as a major contributor to building problems. The ASHRAE Commissioning Guideline (ASHRAE 1996) provides essential guidance for the life of a building. Commissioning has become increasingly common in the 1990s. Renovation during continuing occupancy is another major contributor to problems (ALA 1997). Recognition of potential hazards from renovation has led to widespread implementation of measures to isolate construction zones, to use temporary ventilation, and to protect occupied areas from dust, vapors and fumes.

2.4 Operations and Maintenance

Maintenance cutbacks can lead to IAQ problems (ALA 1997; Sieber et al. 1996). The costs of the associated health effects, discomfort and loss of productivity may be far greater than the presumed savings from the avoided maintenance (Fisk and Rosenfeld 1997). Shifting from reactive to preventive maintenance contributes to improving IAQ, and should be planned for during building design and material selection. Interior HVAC surfaces must be accessible and cleanable to avoid microbial amplification, especially in high moisture areas such as cooling coil drainage pans and humidification systems. Moisture intrusion that is not rapidly corrected can lead to fungal contamination and material damage (ALA 1997). Cost-saving cleaning strategies leave many buildings dirty.

3.0 CONCLUSIONS AND RECOMMENDATIONS

ASHRAE has an important influence on building design, operation and maintenance, which strongly affect IAQ. ASHRAE Standards 62.1 and 55 have been the major U.S. national guidelines on indoor environmental management for many years. ASHRAE will continue to improve these standards, promote their broad acceptance and implementation, and support relevant research.

ASHRAE recognizes that more research is needed on the causes and health and economic importance of IAQ problems and their solutions, including scientifically supported ventilation rates. ASHRAE recommends expanded public and private support for research on IAQ and its effects on people.

ASHRAE recognizes that more widespread implementation of available IAQ knowledge, technologies and practices could significantly improve indoor environments, comfort and health. ASHRAE will continue IAQ educational programs for its members. ASHRAE recommends continued government support for related education and implementation programs.

Building energy efficiency and IAQ are interrelated but not incompatible. These two issues should be considered in tandem within ASHRAE and within all other building energy and IAQ programs.

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